The Report Committee for Andrew Jacob Heermans
Certifies that this is the approved version of the following Report:

The Meta-Disciplinary Rhetoric of Metabiology: Reconsidering the Role of Disciplinarity in Rhetorical Stagings of Scientific Controversies

APPROVED BY
SUPERVISING COMMITTEE:

Davida Charney Supervisor

S. Scott Graham

The Meta-Disciplinary Rhetoric of Metabiology: Reconsidering the Role of Disciplinarity in Rhetorical Stagings of Scientific Controversies

by

Andrew Jacob Heermans

Report

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Arts

The University of Texas at Austin

December 2018

Abstract

The Meta-Disciplinary Rhetoric of Metabiology: Reconsidering the Role of Disciplinarity in Rhetorical Stagings of Scientific Controversies

Andrew Jacob Heermans, M.A.

The University of Texas at Austin, 2018

Supervisor: Davida Charney

This project interrogates how scholars in the rhetoric of science understand and stage controversies within scientific discourse communities. In the paper, I argue that scholarship in the rhetoric of science does not offer a consistent theoretical framework for addressing disciplinary interactions that take rhetorical advantage of extant connections between disparate fields/disciplines to render one discipline in terms of another at the ontological or essential level. By offering an extended rhetorical analysis of one such case, Gregory Chaitin's "Metabiology", I argue that this kind of disciplinary interaction has significant rhetorical import for scholars addressing scientific conversations and the controversies that unfold, but are also at work within the scientific pre-stagings themselves. Distinguishing between intra-disciplinary, inter-disciplinary, and finally meta-disciplinary stagings of scientific controversies within rhetoric of science literature, this paper offers a provisional heuristic that aims to refine how scholars in rhetoric approach scientific controversies as being already-scientifically distinct from other controversies, yet somehow explanatorily amenable to rhetorical analysis. Recent scholarship has indicated that this is a broadly unaccounted for duplicity within the extant rhetoric of science literature's and my paper argues that Chaitin's project of Metabiology offers an honest animation of a post-incommensurability rhetoric that, perhaps through theoretical and methodological projections of inter-disciplinarity as an end in itself, results in a disciplinary hierarchy that does more rhetorical violence than intra- or inter-disciplinary frameworks would let on.

Table of Contents

The Meta-Disciplinary Rhetoric of Metabiology: Reconsidering the Role of Disciplinarity in Rhetorical Stagings of Scientific Controversies

I. Introduction

The Controversy of Controversies

What distinguishes, if anything, a "scientific controversy" from the arguments and debates of the layman? In their recent paper, *There's No Such Thing as a Scientific Controversy*, Scott Graham and Linda Walsh argue that in general, moments when scientists appear prompted to persuasively negotiate how their work is received either within or across scientific disciplines/fields, have been used by rhetoric of science scholars to render (or produce) "rhetorical and political dynamics of science that would otherwise remain invisible." (Graham & Walsh, 1). Despite this valuable function, Graham and Walsh argue that there are unaccounted for rhetorical features/functions in the various uses of the term "scientific controversy", particular "backstage demarcations" that uncritically and *a priori* accept the demarcation claims of scientific discourses themselves, leading to a "rhetorical engine that will accept only scientific values as warrants for ending (a) controversy" (24). Such backstage rhetorics of demarcation, Graham and Walsh argue, have led to a presumption that there is something different and special about scientific rather than normal controversies *and* that this is accessible and accountable for and by rhetorical analysis. In other words, the privileging of scientific controversies in the rhetoric of science can often 'sneak in' the authoritative rhetoric in scientific discourses to (paradoxically) justify and render exigent the need of rhetoric to clarify or enable communication within a given scientific discourse setting, where persuasion or consensus is not being achieved.

One example they give is that throughout *Rhetoric and Incommensurability,* (Harris, 2005), a collection of essays by rhetoricians on the topics of incommensurability and scientific controversies, Graham and Walsh identified only one of the 11 authors, Alan Gross, who, rather than treating controversies as "historical *faits accomplis* even while stressing the(ir) rhetoricity", argued "that declaring something a "scientific controversy" was, in itself, an essentially rhetorical move" (2). In the article, Graham and Walsh detail the findings from a study that assessed 137 articles (from 23 journals) in the rhetoric of science, and found 81 instances of articles dealing with "scientific controversies" that were "most frequently staged as paradigm revolutions, explicitly in a Kuhnian idiom" (7), citing Darwinian evolution, punctuated equilibria, sociobiology, oxygen chemistry, and ecotoxicology as "prototypical exemplars" taken up in rhetoric of science scholarship. Crucially, such "Kuhnian" stagings of scientific controversies will contain or deploy *some* notion of incommensurability to present or indicate (if only to resolve) a lack of consensus among thinkers, theories or paradigms. Graham and Walsh's study indicates further that "situational analyses of "scientific controversies" in (their) sample staged them as functions of incommensurability---diachronic and synchronic---generally without acknowledging this distinction" (13).

Harris's Typology of Incommensurability

The distinction between *diachronic* and *synchronic* kinds of incommensurability Graham and Walsh use is from Randy Allen Harris's "incommensurability suite", a typology of incommensurability developed in his introduction to the aforementioned collection *Rhetoric and Incommensurability*. Harris charts the influence that notions of incommensurability, developed largely by (Thomas Kuhn and Paul Feyerabend), have had upon the field of rhetoric in general, and the rhetoric of science in particular. Speaking of the broader "rhetorical turn" that inaugurated what now comprises the sub-discipline rhetoric of science, Harris argues that while "no single concept can be charged for the general movement (the "rhetorical turn") or the specific sub-field (rhetoric of science)... if we wanted to choose only one, as a metonym for all of the issues and interests feeding into the rhetorical investigation, the hands down winner would be incommensurability." (96). In other words, rhetoric generally treats incommensurability is the *sine qua non* of a scientific controversy, as well as for the need or amenability of rhetoric to intervene upon disputes surrounding scientific theories and between scientific disciplines. However, as the nearly book-length introduction to the collection demonstrates, there is no single, simple definition or deployment of the term "incommensurability" in rhetoric of science scholarship (and for that matter, even in the work of Kuhn and Feyerabend), but rather a constellation of distinct yet overlapping usages of the term.

Harris identifies two distinct ways in which "the word is deployed in the relevant discourses influenced by Feyerabend's and Kuhn's introduction of the term—one categorical, one graduated." (21). In terms of the categorical deployment, Harris defines four "species" or categories of incommensurability: brick-wall incommensurability, cosmic incommensurability, semantic incommensurability and pragmatic incommensurability. *Brick-wall* incommensurability "labels situations in which hopelessly stymied, where each party can only hear gibberish", *cosmic* "labels a situation in which communication is severely hindered because of different perceptions of the "same" phenomena", while *semantic* labels situations wherein communication is complicated because "clusters of meanings used by the parties are out of synch (with each other)", and *pragmatic* labels "a situation in which argumentation is rendered very difficult because themes and practices are out of synch" (22) because there are different values being appealed to, "often covertly and vaguely" (22).

The second model of incommensurability Harris identifies is complementary to the first, described as a kind of metaphorical thermometer that identifies "degrees, rather than categories, of incommensurability---a scale that runs from total homogeneity of paired symbolic networks (theories, languages, worldviews) to total heterogeneity." (23). For Harris, the scale from high to low efficiently maps onto the categorical approach, as "neither model works sufficiently on its own" because "the type of incommensurability may often be much less important than the amount" (23).

The final critical facet of incommensurability that for Harris defines how the term is used in the rhetoric of science (though as we shall see, not necessarily accounted for or explicated by rhetoric of science scholars themselves), the dimension of "temporal proximity" which Harris models through the Saussurean terms *diachronic* and *synchronic*. This facet of incommensurability concerns the question of populations, aims to answer the question of "incommensurability between whom?", and the linguistic analogy maps cleanly onto his other approach, where incommensurability across time (diachronic) "tend(s) to correlate with high readings on our incommensurometer" (24), while synchronic incommensurability, "when two programs are on the disciplinary table at the same time" (23) tends to correlate with lower readings, at the *semantic* level rather than the high-degree *cosmic* category.

Towards the Question of Disciplinarity

In their study of scientific controversies, Graham and Walsh apply Harris's *suite* to articulate the differences among usages of the term "scientific controversies", finding in instances of both synchronic and diachronic incommensurability a compensatory presumption of dialectical, rational resolution or closure available through rhetorical means. It is important to note that the dialectical nature of these staging demand the presence of bifurcated parties, be they individuals or disciplinary communities, which inaugurate the crucial "boundary work" that presumably requires participants in the controversy to use rhetoric to achieve consensus. Graham and Walsh identify two primary forms of boundary work staged throughout the literature: demarcation, "designed to fence participants out in order to simplify and speed closure of a dispute", and translation, "designed to create unity between diverse communities and worldviews" (18). In both cases, the authors argue, there is a "dialectical model of controversy resolution" (19), an expectation that the controversy will close or resolve inevitably, rationally and dialectically. They conclude the paper by arguing that to some degree "all controversies are the results of rhetorics of demarcation" (24), and that the difference between "scientific" and other controversies that the rhetoric of science implies arises from treating of boundaries[1] "as prior to the analysis rather than contingent and strategic articulations by not only the participants in the controversies but also the critics analyzing them" (23), meaning rhetoricians of science "tacitly privilege, *a priori*, scientists' demarcation claims" (24).

In this paper I argue that an important component underlying the demarcations within so-called scientific controversies that needs further analysis is that of *disciplinarity*. A crucial component of the demarcation rhetorics that Graham and Walsh identify as being inherited or recapitulated by rhetoric of science stagings, I argue, is the way in which a scientific field or sub-discipline attempts to stabilize its own disciplinary autonomy through epistemic boundaries and methodological prescriptions, and how this in turn influences interactions across disciplines, be they competitive or cooperative. I am proposing a theoretical framework that focuses particularly on the *disciplinary boundaries* presented in rhetorical stagings of scientific controversies. I argue that rhetoric of science scholarship has historically emphasized what I am calling *intra*- and

[1] Graham and Walsh's analysis of the literature's orientation to scientific controversies offer a substantive validation of the criticisms Randy Allen Harris made in the introduction to his edited collection, *Landmark Essays on Rhetoric of Science: Case Studies*, published in 1997. Under the section "Conflict in Science", Harris argues that while "the rhetorical study of scientific conflicts grew naturally from the Kuhnian roots of rhetoric of science, with its emphasis on upheaval and revolution…none of the scientific debates investigated rhetorically (in this volume or elsewhere) are truly revolutionary" (xxxii). Harris goes on to say that while "some rhetoricians have brushed up against revolutions—Campbell's work on the natural selection controversy, Gross's and Bazerman's on the corpuscular light controversy, Gross's on the heliocentric revolution—these studies are invariably sympathetic with only one side, and always the winning side at that" (xxxii).

inter-disciplinary stagings, but the literature does not present or prescribe a stable conceptual treatment of controversies that arise at what I argue is best considered the *meta-disciplinary* level of relational interaction or staging. What is indicated by the label of *meta-disciplinary* are moments when a perceived likeness across disciplines moves from the status of a rhetorical figure which may characterize a methodological implement or an epistemological goal, to a primary status as ontology, rendering one field as philosophically prior to another in a manner that preemptively forecloses the kinds of incommensurability encountered in intra/inter-disciplinary controversies, but does so by paradoxically and violently inaugurating a new relation of "togetherness-in-sameness".

The case I will be using to exemplify this meta-disciplinary kind of controversy is "Metabiology", an emergent field of study proposed by mathematician Gregory Chaitin which aims to find "a sufficiently rich mathematical space to model the space of all possible designs for biological organisms, to model biological creativity", by developing a model "sufficiently simple to permit rigorous proofs or at least heuristic arguments as convincing as those that are employed in theoretical physics"[2]. The ambiguity and tension in Metabiology's seemingly simultaneous status as both an experimental toy-model and a metaphysical affirmation (of a controversial equivocation of biological and mathematical ontologies), has led to a meta-disciplinary controversy about the relationship between pure mathematics and biology. By indicating a "meta-disciplinarily" staged controversy, I hope to offer the rhetoric of science a way of approaching questions

[2] Chaitin, *Metaphysics, Mathematics and Metabiology*, 2011, pg.7.

of scientific imperialism and disciplinary autonomy through an analysis of the meta-disciplinary features of Gregory Chaitin's mathematical foray into theoretical biology.

II. Intra-disciplinary and Inter-disciplinary Stagings

Randy Allen Harris argues that two primary claims underwrote the development of the rhetoric of science in the 1970s, firstly that "science is not solely the province of individuals with beakers or telescopes or accelerator photographs, but of communities with conferences, journals, values, and goals", and secondly that "there is no single scientific method, but a (constrained) plurality of approaches, or styles, that differ from science to science, program to program, community to community, all of them powerfully mediated by language" (xvi). These claims, Harris argues, lead to the crucial implication that "the virtues of a scientific claim come not only from the way it is mapped against nature, but from the way it is mapped into the context of specific approaches and communities" (xvi). I am arguing that in general *approaches* indicate an intra-disciplinary emphasis, while *communities* indicate an intra-disciplinary emphasis.

Intra-disciplinarity

Stagings of intra-disciplinary conflicts can be characterized by moments where different epistemologies and/or methodologies compete within the same field or discipline for the status of proof: what counts as evidence is questioned in relation to shared intellectual goals within a disciplinary boundary. This kind of controversy is a frequent subject of rhetoric of science scholarship, where a "disciplinary stalemate" has developed due to lack of consensus regarding particular methods of accomplishing a consensual goal. Intra-disciplinary controversies such as Watson & Crick's attempting the goal (among many others in their and related fields) of finding the physical structure of DNA (Bazerman, Gross, Halloran), controversies amongst archeologists regarding what counts as evidence for determining when and how humans first came to the Americas (Fahnestock), the interpretation of data surrounding *parthenogenesis* reproduction in amphibians (Myers), and the controversy surrounding punctuated equilibrium and adaptationism within evolutionary biology (Selzer et al.), are but a few of many available examples in the rhetoric of science. In terms of Harris's incommensurability suite, these are generally associable with synchronic, semantic-pragmatic, and relatively low levels of incommensurability. While in general it is more likely for an intra-disciplinary staging to be given "among discourse communities or argument spheres at the same time" (Graham & Walsh, 12), it is not always the case that paradigmatic concerns or cosmic features (worldviews or philosophical axioms) are shared across disputants within the same field or discipline.

The case of Stephen Jay Gould and Niles Eldredge's concept of *punctuated equilibria* proposed in 1972 indicates a controversy within evolutionary biology (though both Gould and Eldredge were *both* paleontologists and evolutionary biologists) that involved the epistemological status of fossil evidence *for* the field of evolutionary biology (and thus the methodological approach *to)*, indicating a primarily intra-disciplinary conflict. However, Graham and Walsh indicate in their analysis of Lyne and

Howe's (1997) and Zagacki & Keith's (1992) essays on the controversy, the stagings of the controversy an undeniably *diachronic* and both employ varying degrees of "old-guard vs. rebel paradigm" diachronic ontologies of incommensurability. This observation suggests that the question of disciplinary staging is to some extent separable form the question of diachronic/synchronic incommensurability, and this is further evidenced by Graham and Walsh's concusions that these senses of incommensurability are often amenable to the rhetorical choices in staging themselves.

Inter-disciplinarity

Where intra-disciplinary stagings generally show a scientific field with a shared intellectual goal debate over the means by which said goal be can properly accomplished, inter-disciplinary-staged controversies concern the potential value of combining distinct fields, or putting distinct fields into conversation for the benefit of one or both fields. Rhetoricians have studied and theorized a number of moments of scientific controversy, where an emphasis is placed on the discursive and conceptual tensions arising when one field interacts with another field. In terms of incommensurability, it is argued here that the incommensurability of inter-disciplinary conflicts can be pragmatic, semantic, even cosmic, and more frequently than typically synchronic intra-disciplinary conflicts, inter-disciplinary structurings can locate the incommensurability in the tension between *older* and *newer* fields and outgrowths from within fields, so paradigmatic concerns are further implicated.

One example of this mode of inquiry is found in Ann M. Blakeslee's *Interacting with Audiences*. The book focuses on a single case of inter-disciplinary controversy, one in which physicists were attempting to persuade chemists and biologists that they had found a more efficient and reliable method for modeling biological molecules via computer simulation than the method preferred by chemists and biologists. While chemists and biologists championed the method of Molecular Dynamics (MD), physicists argued that a new method called Dynamically Optimized Monte Carlo (DOMC) was preferable to MD, claiming that DOMC was more efficient and flexible, allowing the simulation of smaller molecules and their properties using less computer energy and time than MD. The preference physicists had in moving from smaller to larger molecule simulation was not shared or practiced by chemists and biologists, according to the physicists, and so represents an inter rather than intra-disciplinary controversy, evidenced in a quote from a physicist: "You have to start out small and simple. That's the way it's done in the physics community. There is a tendency among (biologists, chemists) to go right after the big stuff, not mess around with the small stuff." (25). These disciplinary differences, Blakeslee argues, were the primary factors informing the rhetorical challenges the physicists faced in persuading their audience of chemists and biologists to adopt the DOMC method of simulation. The physicists' training was oriented towards general simulation of physical objects and not biological molecules in particular, and the biologists' interest in and use of computer simulation of physical objects was specific to the broader interests of their fields, there was an inter-disciplinary conflict which demanded, according to Blakeslee, much rhetorical sensitivity to their audiences as outsiders entering distinct fields with generally divergent intellectual goals than their own, even though they were in this situation focusing on a shared goal of modeling biomolecules. In other words, while the controversy itself centered on a methodological dispute surrounding a shared goal, the source of this controversy came out of larger differences across the disciplines themselves, which we can take as being *inter-disciplinary* in nature. Further, Blakeslee's analysis indicates that the strictly empirical facets of the physicists' arguments for DOMC, for example the reduced computational burden (in terms of electricity and time required) and the increased accuracy of simulation, were not enough on their own to persuade chemists and biologists to adopt the new methods, and required rhetorical appeals which took into account both the familiarity of the standard MD method to the other fields and fields' different sizes of molecules preferably simulate. In general, inter-disciplinary stagings often treat a controversy as arising through the resultant tensions between distinct fields that come into contact for a particular shared or mutually beneficial goal. Rhetorical scholars in these stagings often treat the social dimensions of text composition within given disciplines as a whole, as “products of a *community* of researchers”[3], and thus focus on the potential incommensurability between fields, and the means by which rhetorical analysis can indicate ways forward for dialectical resolution or consensus across disciplines.

[3] *The Social Construction of Two Biologists Proposals,* Greg Myers, 1985.

The Inter-disciplinary Incursion of Mathematics into Biology: Mendel and Darwin

James Wynn's work on the mathematization of biology in his book *Evolution by the Numbers,* offers a compelling account of the rhetorical dimensions of the inter-disciplinary interactions between mathematics and biology, arguing that the historical mathematization of biology was the result in part of the rhetorical efforts of those who championed mathematical methods in biology. Wynn claims that mathematical reasoning does not argue for itself, and that the epistemological status of mathematical reasoning within biology has been in part earned through the rhetorical mediation of mathematical/statistical methods across priorly untrodden disciplinary boundaries. Wynn traces the historical challenges faced by figures such as Mendel and Darwin, in advocating for mathematical reasoning in the field of biology during moments where mathematical reasoning was not paradigmatically privileged in Kuhnian terms. Qualifying the claims in John Angus Campbell's landmark essay in the rhetoric of science[4] on Darwin, Wynn moves beyond the assertion that Darwin was rhetorician *par excellence* and that *The Origin* is a fundamentally rhetorical text, to consider both the scientific and rhetorical role of mathematics in his theory. Wynn focuses on the rhetorical challenges Darwin faced in advancing a quantitative theory of species-origin, given the paradigmatic status of biological theorization of organism development. The rhetorically animated front-stage of his theory as represented in the published version of *The Origin*, according to Wynn, has obscured the mathematical basis of his theorization of evolution

[4] *Charles Darwin: Rhetorician of Science*

by natural selection. And in focusing on Darwin's deliberate championing of mathematically supported theorizations of biology, Wynn argues that Darwin should properly be understood as both a rhetorician *par excellence* and a "pioneer of mathematical argument in the study of organic phenomena". Wynn's analysis of Gregor Mendel's statistical hereditary method shows how Mendel's theory and the rhetoric supporting it operated fundamentally upon an analogy between mathematics and nature. The primary sense in which math is seen as rhetorical in Mendel's case involves the audience reception at moments of disciplinary border-crossing, when "mathematical arguments, no matter how compelling or analytically robust, compete with a host of other beliefs" (22), and Mendel faced the challenge of turning his mathematically structured empirical evidence into biologically comprehendible "rational principles".

Karl Pearson at the Edge of Inter-Disciplinarity

While Darwin and Mendel used and advocated for the *integration* of mathematical methods into the study of biology and so indicate for Wynn the rhetorical challenge of advancing an inter-disciplinary methodology within an unsympathetic biological paradigm, his chapter on Karl Pearson, the first "radical disciple" of biometry (the statistical approach to biological analysis founded by Francis Galton) moves to the edge of inter-disciplinarity. Using Perelman and Olbrechts-Tyteca's concepts of *values as divisions/virtues* and *value hierarchies* to characterize the two sides of the Mendelian-biometric debate at the end of 19th century, Wynn builds a dichotomy between Pearson and his critic William Bateson that centers on the role of mathematics in biology. While

Bateson argued from the position of *value as difference*, where "multiple methods (including mathematics) are required to develop reliable scientific knowledge about evolution, variation and heredity" (Wynn, 185), Pearson advocated for the "development of a new mathematical biology, guided *exclusively* in its investigations of evolution and heredity, by the principles and practices of mathematics". Framed within the conceptual space of Perelman and Olbrechts-Tyteca, "what had previously been distinct but not incompatible values (mathematical and other approaches to biology) had suddenly begun to aggregate into value hierarchies of competing virtues" (Wynn, 168).

According to Wynn's argument, Pearson's position that biology could be done mathematically without experimental approaches, formed a *value hierarchy* where distinct values/approaches were assigned disparate levels of *virtue*, where "measurement and mathematical reasoning is taken as the only means of developing knowledge about nature" (187). With this value hierarchy that places the mathematician at the top, "science becomes the process of developing and testing mathematical theory through the collection of data...organizing the hierarchy of values to place mathematical analysis and description as the vanguard of the scientific process". Two important considerations arise out of Wynn's treatment of Pearson's biometric program, the first being the question of disciplinary interaction and the second being the question of the motive to assign mathematics such an ontologically and epistemically privileged status. Bateson and other Mendelians saw mathematical approaches as one node in the network of biological inquiry, yet Pearson's value hierarchy solely privileging mathematics presents a controversy at the limits of inter-disciplinarity, and allows us to shift our focus without much difficulty to the case study through which the concept of meta-disciplinarity will be primarily framed, that of Gregory Chaitin's Metabiology.

III. Mathematics, Biology and the Limits of Inter-disciplinarity

Meta-disciplinarity and Metabiology

Metabiology is the recent foray into theoretical biology (or not, according to his critics) by Argentinian-American mathematician, computer scientist and co-founder of Algorithmic Information Theory (AIT)[5], Gregory Chaitin. Metabiology is a theoretical project aimed to provide an indubitable 'proof' of Darwinian evolution at the abstract level of pure mathematics, arising from the peculiarly discipline-specific observation that "if you compare theory in biology with theory in physics, and if you look at biology as a mathematician, things are not that convincing...there is empirical evidence of Darwin's theory, but there is no mathematical proof." (*Proving Darwin,* 9). Attempting to offer as simple an explanation of Metabiology as he can, Chaitin says: "You've heard people refer to DNA as a computer program? Well, that's the whole idea: to make this metaphor into a mathematical theory of evolution." (*PD, 3).* So, what makes Chaitin's metabiological project an exemplar of a controversy arising out of a meta-disciplinary approach, and for that matter, what exactly is meant by or conveyed in the term "meta-disciplinary" that isn't in the aforementioned intra- and inter-disciplinary stagings? The term "meta-disciplinarity", it must be noted, is already being circulated within scholarship, though the extant usage of inter-disciplinary pedagogy expressing what can generally be understood as a discipline fostering and guiding inter-disciplinarity, but the existing usages of the term indicate a metatheoretical holism with a general, oft-ambiguous connective tissue spanning through and connecting across a few (or potentially *all)* disciplines. The extant use of the term is consistently organized around a pedagogical or methodological drive to increase inter-disciplinarity across disciplines and the perspectives they contain. wherever the term is (infrequently found), there is present a metaphor of 'unity through diversity', or "togetherness-in-difference"[6]. What I mean by meta-disciplinary is quite different if not the inverse of the "togetherness-in-difference" sense of meta-disciplinarity, indicating moments when a perceived likeness across disciplines moves from the status of a rhetorical figure which may characterize a methodological implement or an epistemological goal, to a primary status as ontology, rendering one field as philosophically prior to another in a manner that preemptively forecloses the kinds of incommensurability encountered in intra/inter-disciplinary controversies, but does so by paradoxically and violently inaugurating a new relation of "togetherness-in-sameness". I am not arguing that the previous uses are the *wrong* usage of the stable concept of "meta-disciplinarity", but rather that Gregory Chaitin's project of

[6] Alexander Werth's *Unity in Diversity: The Virtues of a Meta-disciplinary Perspective*, distinguishes the term from more commonly used concepts like inter-disciplinary or multidisciplinary, by claiming that a meta-disciplinary perspective "transcends or supersedes traditional disciplinary boundaries to create a truly holistic, systemic, integrative worldview...instead of merely linking two or more customary fields together at their margins, a meta-disciplinary focus reveals that all such fields are fundamentally related in numerous significant ways" (36). LuMing Mao argues that a meta-disciplinary approach "is informed by an outright rejection of any external principle or overarching context to determine the context of the other...rely(ing) on terms of interdependence and interconnectivity to constitute and regulate representation of all discursive practices" (218).

Metabiology indicates an entirely different sense of meta-disciplinarity, one which articulates the disciplinary interaction between mathematics and biology in a contemporary moment of seemingly *cosmic* and (yet) *synchronic* incommensurability between the stable concepts of theoretical biology generally and the methodologically experimental and philosophically controversial "Metabiology" of Chaitin.

To return once more to Wynn's analysis of Pearson, Wynn states that "in this Positivistic biology (Pearson's proto-biometry model), the goals of physics merge with the goals of biology. Both disciplines would be interested in describing the widest ranges of phenomena in the briefest possible formulae within the routine of perceptual experience" (156). And so the connective tissue that both Pearson and Chaitin identify between mathematics and physics was crucial to the requisite connections developed between mathematics and biology for each thinker. So, we can rightly understand the controversial relationship or intersection between mathematics and biology at the ontological level by attending to the rhetorical features that would be considered inter-disciplinary between math and physics but are combinatorically featured in Chaitin and Pearson's cases as operating at the meta-disciplinary level between mathematics and biology when rhetorically oriented towards an ontological hierarchy. Wynn indicates that Pearson "maintained, despite his own positivistic convictions, that mathematical reasoning unaccompanied by observation or experiment could be used as a legitimate first step to developing theories about nature" (156).

More than a century later, Gregory Chaitin "puts it (more) bluntly" by stating that from the perspective of Algorithmic Information Theory, "mathematics and physics are not that different. In both cases, theories are compressions of facts, in one case facts we discover in a physics lab, in the other case, numerical facts discovered using a computer" (Chaitin, 2007, 303). In fact, we can narrate Chaitin's broader trajectory from Algorithmic Information Theory to Metabiology in large part through the mediatory role physics played between pure math and biology for Chaitin. In a 2003 paper titled *Leibniz, Information, Math and Physics,* Chaitin traces the theoretical ancestry of his work in Algorithmic Information Theory (AIT), all the way back to Leibniz's 1686 *Discourse on Metaphysics*, arguing that the philosopher "almost invented algorithmic information theory of the sub-field of information theory (AIT) he co-founded in the 1960s alongside Ray Solomonoff and Andrey Kolmogorov[7], and detailing how it has led to what he sees as an emergent "digital philosophy paradigm" that displaces energy and matter with algorithmic information.

Tracing Metabiology

While 'officially' unveiling the project of Metabiology in his 2012 book *Proving Darwin: Making Biology Mathematical*, Chaitin was pondering the potential biological applications and implications of AIT since he began developing his version of the theory late in the 1960s. The final section in his 1977 essay *Algorithmic Information Theory* which first presented his version of the theory was titled "AIT and Biology", and in it Chaitin claims that the "most important" challenge to the theory was the question of if a

[7] *Chaitin, PD, 35-37*

theoretical mathematical biology could be developed from it. Chaitin cites John Von Neumann's desire to "isolate the basic conceptual problems of biology from the detailed physics and biochemistry of life as we know it" (*AIT,* 357) as the source of his own desire to develop a mathematical theory of biology, and to a large degree the Metabiology that followed nearly 3 decades later can accurately be understood as a response to the exact same desire. In the essay *A Mathematical Theory of Evolution and Biological Creativity*, Chaitin claims he has "something radically new to talk about" and that "the time is now ripe to combine theoretical computer science with biology and to begin developing a theoretical mathematical biology." (2) Chaitin rather casually dismisses the lot of literature on biology and evolution, saying, "good work, I have nothing against it, but I'm going to ignore most of it and go off in a different direction" (2). This different direction begins with Chaitin reminding his audience that "Darwin begins his book On the Origin of Species by taking advantage of the analogy between artificial selection by animal and plant breeders...and natural selection", and from this insight develops his own rhetorical figure: one between "the random evolution of natural software, DNA, and the random evolution of artificial software, computer programs." This is the essence of the new field of research proposed by the term Metabiology, meaning Metabiology begins with a figure which Chaitin calls an analogy, between the role of information in biological and computational settings. Working at an abstract level, Chaitin sees no problem in theorizing DNA as a "universal programming language", a language with the capacity to express any algorithm. He cites Richard Dawkin's work as teaching him that "bodies are unimportant, they are just vehicles for their genes" (3), which translates metabiologically to the exclusive focus on “digital software” (genomes) rather than the hardware or bodies that are studied in biology. While he is not making explicit ontological claims, there is nevertheless an obvious conceit that evolution at its core is explained by software and not hardware, which informs his choice to ignore the energetic dimensions of biological life, and focus specifically on information. In an appendix in *Proving Darwin*, Chaitin lists the numerous analogies between biology and mathematics that theoretically structure Metabiology. Here are some of the more important analogies he makes:

Computer Programming Languages = Artificial digital software
DNA = Natural Digital Software, Universal Programming Language
Life = Evolving Software
Biology = Software Archeology
Mutation = a program modifying a given organism
Fitness = integer calculated by an organism
Evolution = random walk in space of all possible programs towards increasing fitness[8]

So, as a methodological choice (though an ontological orientation is present as well) Metabiology would, in Chaitin’s own words, “throw away the body and just keep the DNA” He cites Richard Dawkin’s work as teaching him that “bodies are unimportant, they are just vehicles for their genes” (3), which translates metabiologically to the exclusive focus on “digital software” (genomes) rather than the hardware or bodies that are studied in biology. DNA as natural software or universal programming language is made the unilateral agency in organism evolution, and Chaitin is not shy about feature of his theory, but he occasionally makes an effort to explain it as a methodological choice

[8] *PD,* 5-6

resulting from the epistemological goals of Metabiology as a toy-model[9] simplification of biology at a highly abstracted level. And yet, in the immediately following explanation of the rationale behind the choice, it not clear if he is speaking in the register of metaphysics (ontology), methodology or epistemology: "biologists think that every detail counts; they do not distinguish between what is fundamental and what is secondary…the energetics, the metabolism of living organisms is unimportant, all that counts is the information" (*MTE)*.

Paradoxically, Chaitin occasionally implies in the same context that this choice is in, (some large) part the result of his apprehension/appreciation of a paradigm shift towards a digital philosophy that displaces matter and energy with information as the essential ontological unit of the universet. Chaitin in 1977 claims that what will eventually become his Metabiology can help to solve a "fundamental problem of theoretical biology": "to set up a nondeterministic model universe, to formally define what it means for a reigon of space-time in that universe to be an organism and what is its degree of organization, and to rigorously demonstrate that, starting from simple initial conditions, organisms will appear and evolve in degree or organization in a reasonable amount of time and with high probability."[10] Chaitin's resultant theory of Metabiology can be understood as an attempt at setting up the aforementioned "nondeterministic model universe(s)" in an effort to elaborate a general mathematical account of Darwinian

[9] Though he does on multiple occasions qualify his project by indicating its status as a toy-model, the condition of Metabiology's possibility *as* even a toy-model (rather than a mathematical fiction completely unrelated to biological reality) is the result of an implicit acceptance of a digital ontology.
[10] Chaitin (1977), 357

evolution that begins from elegant simplicity and leads (potentially) to infinite complexity.

Regarding a definition of life, Chaitin cites the definition given by Maynard Smith and Szathmary, which in his understanding can be simplified into the claim that "you have life when there is heredity with mutations and evolution by natural selection can take place." (4). This definition allows Chaitin to at least in theory search for the simplest, most elegant system that displays heredity and mutations that provably evolves. So, to make things "as simple as possible", Chaitin says, "no metabolism, no bodies, only DNA. My organisms will be computer programs" (4). If Darwin developed his theory of natural selection from an "analogical" movement from the artificial selection of animal husbandry to the natural selection of biological mutations in response to the evolutionary pressure of survival, than as Chaitin sees it, if he can algorithmically model the "evolutionary pressure" given in Darwinian evolution that occupies a middle ground between top-down deductive intelligent design and completely random and non-modular mutation, he will have a mathematical proof of Darwinian evolution at the abstract theoretical level of pure mathematics.

Algorithmic Information Theory

While a comprehensive account of this related conversation beyond the scope of this paper, it suffices for my purposes to outline the basic features of AIT and how Chaitin saw it leading to biology and the related paradigm shift. AIT avoids probability distributions, unlike traditional statistics and information theory, and rather defines randomness through algorithmic compressibility, meaning the fundamental measure of randomness is whether an algorithm can compress any of the information, produce a theory simpler than the phenomena it describes, which Chaitin argues any good theory must be. Algorithmic or program-size complexity is a measure that quantifies algorithmic randomness. AIT thus "studies the size in bits of the smallest program to compute something"[11], and the initial insight that led Chaitin to develop it was that "a scientific theory is a computer program that calculates the observations, and that the smaller the program is, the better the theory".

With the equation "theory = program -> Computer -> output = experimental data"[12] in place, Chaitin developed a theory of randomness based on program-size complexity that presents an information-theoretic reiteration of Godel's incompleteness that re-stipulates the disciplinary relationship between math and physics, as "in both cases understanding is compression, and is measured by the extent to which empirical data and mathematical theorems are respectively compressed into concise physical laws or mathematical axioms, both of which are embodied in computer software." (LIMP, 3).

[11] Chaitin, *Metaphysics, Metamathematics, Metabiology (*MMM*), (7)*
[12] *Leibniz, Information, Math and Physics* (LIMP), 1

This work on AIT, for Chaitin, demonstrates the paradigm shift away from the old mathematics of formal axiomatic theory, showing "how badly mistaken (David) Hibert was to assume that a fixed formal axiomatic theory could encompass all of mathematics" (LIMP, 8). This is the essence of what is termed in Metabiology the *postmodern* of "postmodern mathematics" as it takes seriously and incorporates the philosophical implications of Godel's and Turing's exposure of mathematical incompleteness (undecidability). According to Chatin, traditional pure mathematicians rely on a "sunday school fiction" of mathematical certainty implying absolute truth, and so have much to gain by ignoring or bookmarking the philosophically troubling implications of incompleteness for mathematics understood in the Aristotelian sense as a-rhetorical, creatively restrained and strictly logical[13]. Chaitin is a self-described heretic in this sense, claiming that mathematics requires a sense of creativity, meaning that mathematics is not a mechanistic, closed system, but rather an open system that requires creativity.

Chaitin's Mathematical Creativity

Chaitin's mutlifaceted treatment of "creativity" as equivalent across mathematical and biological contexts is one example that indicates how Chaitin's particular mathematical ontology is idiosyncratic should be at least partially accounted for[14] to understand Chatin's meta-disciplinary staging of biology and pure mathematics. One way

[13] "no one uses *fine* language when teaching geometry" (*Rhetoric*, III, 1)

[14] Though to provide both a full account and a comprehensive rhetorical analysis of all of Chaitin's peculiar thoughts on mathematics is beyond the scope of this project.

of getting at how Chaitin understands the term is by considering the role of the Busy Beaver Function (BB Function) in Metabiology.

Chatin "compares the natural creativity of the biosphere to a different type of creativity, namely that inscribed in the essence of mathematics...the creative potential inherit to mathematics is considered to be well rendered by the BB Function."[15] Stated simply, the Busy Beaver Problem is that of "concisely naming an extremely large positive integer, an extremely large unsigned whole number" (5). Why, according to Chaitin, this is both a problem and a solution in Metabiology is that to even get to the point at which such a large unsigned whole number can be conceived of and considered requires mathematical creativity. Chaitin frames the matter by supposing "you have a large number N and you want to name a larger number. You can go from N to $N + N$, to N times N, to N to the Nth power, to N raised to the Nth of the Nth N times. So to name large numbers you have to invent addition, multiplication, exponentiation, hyper-exponentiation, and this requires creativity" (5). If a single "bit" of biological information and a complex biological organism are considered in their relations to one another analogously to how the number N, and the expression of N raised to the Nth of the Nth N times relate, then the concept of "creativity" is equivalent in both mathematical and biological terms, meaning one expresses a feature of the other, and so we have a clearly figural rhetoric that renders in its expression the convertibility between biological and mathematical accounts of organism development. Crucial to this moment of bio-

[15] Siedlinski, 138

mathematical conversion is the fact that the BB Function for Chaitin gives an (at least theoretically) expression of how Turing's halting problem plays in his metabilogy, since BB(N) grows faster than any computable function of N. In other words, the non-computable infinity of the BB Function is itself only grasped by moments creatively (finite) calculation, which offers a kind of philosophical structure to Chaitin's theory: this computational figure offers a kind of middle ground between a completely random theory of evolutionary creativity, a "brainless exhaustive search, in which the previous organism A is ignored and we try a new organism B at random (without any input)", and intelligent design.

In these two modelings of evolutionary processes, the problems of memory and mutation are distinctly problematic. In intelligent design, evolution cannot be properly considered a functional agency itself, as generational finitude or other arbitrary material factors would be the only conditions separating the simple from the complex, unfit and fit organisms from one another, as a teleological end is operative in fundamentally sequencing any mutation from one level of simplicity to another more complex level. Therefore, both the simple, unfit organisms and the complex, fit organisms are defined by the same entelechial standard of pre-defined optimal fitness related to a *telos*. This would make evolution a contingent rather than necessary factor for biological organisms.

On the other hand, a strictly mathematical calculation demonstrates the inadequacy of models of exhaustive random searching, which prevents any kind of biological memory leading to informatic modularity: "the human genome has 3x10^9 bases, but in four billion years the biosphere has only been able to try an infinitesimal fraction of the astronomical number 4x10^9" (7). In between these two Chaitin articulates the essential posture of Metabiology, where "each of (his) software organisms calculates a single number, a single positive integer, and the bigger the number, the fitter the organism". The unbounded process of increasing fitness that Chaitin demonstrates in theory is the successful component of metabilogy as Chaitin sees it: "this is my current best effort to find the Platonic ideal of evolution, the simplest, most natural system that exhibits creativity and that I can prove evolves by random natural selection." In a more general sense, Chaitin sees his metabiological project as a incomplete but generative movement away from the conventional mathematical models in biology which "talk about stability and fixed points, (but) not about creativity" (11). As he sees it, "in biology nothing is static, everything is dynamic...biology is ceaseless creativity, not stability, not at all" (11).

Chaitin implicates Kuhn within his own philosophical views on science, arguing that "Kuhnian paradigm shifts are not limited to the experimental sciences, they also take place in mathematics, supposedly an *a priori* discipline, a necessary tool of thought." (*PD,* 88). As would happen, he goes on to argue that his project of Metabiology has inaugurated a Kuhnian paradigm shift all its own, one which proceeds from the claim that "pure math is even more biological than biology, which is very complicated but only has finite complexity" (32). Chaitin's attempt to provide a formal mathematical proof of Darwinian evolution, according to him, has placed him within a rich intellectual tradition of what he terms "postmodern mathematics": "Godel, Turing, (Emil) Post and Von Neumann opened a door from math to biology; they gave us the necessary conceptual tool-kit.". What we need, Chaitin claims, to enter this door and enter this new information-based paradigm, is "postmodern discrete algorithmic math to understand biology, not Newtonian differential equations, not old math, not analysis" (34). The paradigm shift presumed by Chaitin is that of the movement from an ontology of energy and matter to an ontology of information, a digital ontology of discretization (as opposed to an *analogue* ontology emphasizing continuity) that sees the universe as a universal turing machine. How this digital ontology rhetorically operates in Chaitin's project is that, in positing a qualitatively homogenous digital ontology that equally implicated in both pure mathematics and biological reality, the epistemic domains of, and boundaries between pure mathematics and biology are respectively integrated and dissolved, which grants (if his meta-disciplinary pre-structuring is accepted) Chaitin the ability to enact a methodology that circumvents the issue of *simulation*[16] and can transpose mathematical proofs directly into the register of bio-ontology.

The aforementioned analogy Chaitin deploys in his theoretical staging that renders qualitative equivalency between "creativity" in biological evolution and the creativity Chaitin finds in pure mathematics (for epistemic expansion or the discovery of

[16] Epistemically and methodologically, simulations place upon an inter-disciplinary bio-computational theory the demand that it be developed and deployed within a context (software space) that simulates (or at least attempts to model) the reality conditions in the observable biosphere, such as limited space, resources and time. This generally limits to some degree the computational/mathematical content to a *instrumental* role, where in Chaitin's case the mathematics takes on a far more robust conceptual (and here argued, ontological) role in the broader theory. However, from a epistemic and/or methodological perspective, the demand of simulation is conservative and constructive in its attempt to delimit mathematical abstraction from biological reality, though *from a rhetorical perspective*, simulations do rather the opposite, visually encouraging the conclusion that biology is ultimately reducible to mathematical expressions, and can be (at least in potential) completely simulated *in silico*.

novel mathematical concepts or objects to occur) comes to function as a rather esoteric defense for his metabiological methodology of mathematical proof over computer simulation. Given the postmodern condition of mathematics, Chaitin need not fear or pejorate the idea of randomness, and his Metabiology treats randomness as the condition of possibility for creativity, embracing randomness theoretically and methodologically. Since Metabiology is essentially the "mathematical expression of the interaction between randomness and uncomputability giving rise to novelty, increasing conceptual complexity in the form of new information content"[17]. So, analogically speaking, excursions into randomness, experiments of the metabiological variety, are themselves *performaces* of mathematical creativity rather than simulations of creativity indicating definitions or descriptions of creativity. You see, for Chaitin, we can only *be* creative in doing, and cannot intellectually know creativity outside of its performance, "creativity is by definition something we don't know how to do" he says, we don't wake up and say "I am going to be creative" and then are, but rather discover creativity after the fact (this is a variation/adaptation of the maxim that one cannot be conscious and know consciousness in the abstract). And that is really what Chaitin hopes his Metabiology will achieve, if not now, at some point, through its random (creative) walks in software space. The productive trajectory of Metabiology as a field/discipline is left in a profoundly vulnerable position, hinging quite literally upon the rhetorical characterization of randomness as either a leap into uncharted, exciting and epistemically generative

---

[17] Virginia Chaitin, *A Philosophical Perspective on a Metatheory of Biological Evolution* (2016).

territory, or the falling into a lack of purpose, intelligence, meaning, and thus coherence with the biological world. The rhetorical difference between the two determines if one sees Metabiology as valuable (either theoretically or experimentally) or if one sees it as leading to an intellectual no man's land, a surreal or fictional world of mathematical fantasies.

Chaitin's Critics

Let us now consider Chaitin's critics and consider the incommensurabilities they erect to dismiss Metabiology or distance it from *real* theoretical biology. According to Polish Scholar Radoslaw Siedlinski, Chaitin's Metabiology is highly controversial and problematic, for both computer scientists and biologists, since (he claims) the computational theory Chaitin makes use of is strictly theoretical, meaning it cannot be applied to any existent hardware, or be modeled in any existent programming language, and his treatment of biological information is seen by biologists as simplistic to a fault and highly "genocentric", focusing only on the information contained in genomes and not the physical systems that harbor said "information"[18]All in all, we can roughly posit four problematic aspects of Metabiology, two from the perspective of mathematics or computer science, two from the perspective of biology. From the math/computer science angle, the first "problem" with Metabiology is the fact that the procedures he describes are accessible only in the domain of pure mathematics, as they involve the use of an "oracle", which solves the halting problem theoretically but is uncomputable on any

[18] *Turing Machines and Evolution: A Critique of Chaitin's Metabiology*

existing hardware, and cannot be modeled or implemented within any existing programming languages. Closely related, the second issue of unlimited resources "equip(s) the evolving organisms-programs with infinite computing resources...things that do exist in reality, or are unknowable." (Siedlinski, 141).

Both of these issues are explicitly acknowledged by Chaitin, who carefully hedges any and all conclusions/implications to be made from Metabiology through this caveat, there is the invitation for rhetorical analysis, Siedlinski and others[19] suggest that he harbors a suppressed philosophical faith in his theory that denies the sincerity of his caveats. From the position of biology, the indicated problems with Metabiology are its directionality which imbricates a strong teleology within Chaitin's theory, and "the discrepancy between Chaitin's assumptions and the findings of modern evolutionary biology" (142), which to biologists renders Chaitin's model simplified and unrealistic. Ewert, Dembski and Marks paper concludes that "while elegant in conception, Metabiology departs from reality because it pays no attention to resource limitations" (8). I argue that there is really just one critique present at the base of these various critiques, that "it isn't real… it does not cohere with or meet basic reality conditions of biology". I would further argue that it is spurious to claim that these are critiques are or would be coming from computer scientists or mathematicians themselves. It is ironic but not surprising that in the section of the essay that claims to present problems with the theory "from the point of view of a mathematician or computer scientist" (140), the only

[19] Ewert, Dembski and Marks. *Active Information in Metabiology.*

computer scientist/mathematician Siedlinski quotes is Chaitin himself. The use of Oracles is not “controversial” unless you are implying an ontological relationship to biological reality, as the analogy in translation across disciplines would imply an evolutionary theory that is guided by some intelligence. Claiming there is a coder behind the code or a programmer behind the program is only controversial if the code is now DNA or the programs are now mutations, literally. But do Chaitin’s critics clarify whether he is claiming that DNA = programming language *in* his theory or in the world his theory exists within? I have already indicated in a variety of ways that Chaitin suggests both and it is not clear how he himself *truly* values his theory. These critics end up positing brick-wall incommensurability between Metabiology and fields that are part of and used within Metabiology itself, which is erroneous.

The meta-disciplinary orientation is the issue, not the mathematics and computer science Chaitin uses; Chaitin is good at math. In posing this brick wall incommensurability. they so project an extraneous and curious impetus to strip Metabiology of its use to *any* scientific discipline and render it a fantasy, leaving Chaitin and his theory on an abandoned disciplinary island to stave. As the critics see it, they have no obligation to help Chaitin and risk the same fate, as Chaitin’s project was oriented around this deliberate jumping into randomness and thus meaninglessness, which he mistook for creativity. What if there was another way to deny Chaitin his ontology while remaining intellectually generous and humble in light of a complicated theory from an accomplished scholar?

III. Conclusion: Rhetoric (in) and Mathematics

Infinitesimals and Mathematical Creativity

A final detour back into (perhaps just barely) inter-disciplinary rhetorical scholarship, this time dealing specifically with the relationship between rhetoric and mathematics, may help to further clarify the sense of “creativity” that Chaitin renders equivalent across disciplinary and philosophical boundaries, as well the broader metadisciplianry staging enacted in Chaitin’s project. G. Mitchell Reyes’s rhetorical scholarship on mathematics (footnote) argues that there is good reason for mathematics to be attended to by rhetoricians both in its communicative constraints across disciplines, its inherent status as a form of knowledge, and its relationship with rhetoric. Arguing that when rhetorical scholarship *does* (infrequently) consider mathematics, it is more often than not occupied with the “strategies between mathematicians and the rhetorical influence of mathematics in other discursive fields”. Through this observation, Reyes identifies a theoretical gap in the field’s treatment of mathematics, in which the “argumentative logics that constitute mathematics’ productive vocabulary remain unquestioned”. In this way, Reyes argument can be incorporated into the conversation surrounding Metabiology and meta-disciplinarity, as Reye’s efforts to focus on the “argumentative logics that constitute mathematics’ productive vocabularies” indicate (in this argument) a particular instance of a broader desire to move extra-disciplinary focused rhetorical scholarship from an inter-disciplinary to a meta-disciplinary perspective, and further helps us address the convoluted figural features that theoretically permit and rhetorically empower Chaitin's meta-disciplinary absorption of biology into pure mathematics.

An example of this meta-disciplinary focus can be seen in his argument about the role of rhetoric Leibniz's and Newton's work with infinitesimals, which he analyzes through his theory of two operative "planes" of what we can call rhetoric, the familiar (to rhetoric of science) plane of "situated rhetoric characterized by criticism, debate, and response.", and the less considered plane where (rhetorical) "discursive formations give shape and substance to" novel mathematical concepts. Calling the former "situational" and the later "constitutive", he sees Newton and Leibniz's work with infinitesimals as instances in which it is crucially "the persuasive arguments" which constitute the substance of infinitesimals as non-empirical, and non-representational mathematical objects. Reyes introduces the concept of the infinitesimal through the Newton and Leibniz's development of integral and differential calculus, which was capable of studying the movement of objects through space, and represents one of the crucial historical and theoretical contributions to mathematics generally. They did this through the use of infinitesimals, and this is reflected in their new calculus initially being titled "infinitesimal calculus", where the area under a curved line is broken down into an infinite number of rectangles, which renders the curve into a sequence of straight lines. From this, argues that the status of the infinitesimal as non-representational and non-empirical, meant that it "did not have immediate recourse to an already established set of discursive rules" and could not be represented geometrically or physically.

Though Reyes does thoroughly engage the rhetorical situations Leibniz and Newton were faced with given the status of their audiences, doing so leads him to argue not simply that scientific and mathematical concepts can and do transform thought, but that “such a concept (the infinitesimal) is wholly rhetorical”, finding “its substance” to be almost exclusively “in the rhetorical arguments circulating around” (181). Reyes goes beyond many prior rhetorical considerations of mathematical invention by focusing on the “constitutive rhetoric” that is implicated in the development of novel mathematical ideas.

We cannot completely accept and incorporate all of Reyes claims about the relationship between rhetoric and mathematics *in general* without qualifying that there is an extent to which, in terms of the theoretical framework I am here deploying, Reyes’ argument that mathematical concepts and/or objects can be *wholly constituted* through rhetoric(al figures) can be seen itself to risk a (perhaps mild) form of meta-disciplinary violence in restipulating one field (or crucial concepts within) entirely though the substance of another, in particular moments of presumed incommensurability. Rather we can adopt a slightly constrained version of his claims and argue that while Chaitin’s mathematical concepts outside of the meta-disciplinary gamut of Metabiology cannot reasonably be understood to be *wholly* or *primarily* constituted through rhetoric(al figures)[20] within the (meta)disciplinary matrix of Chaitin’s project the role that Chatin’s

[20] The cannonical status of earlier work in AIT is uncontroversial for both information theorists and computer scientists, and his work has further been generativity taken up in various theoretical physics contexts, and it would be absurd to narrate this entire legacy through the impetus of rhetoric and in this particular deployment.

mathematical concepts (and attached philosophical beliefs informing the meta-disciplinary seizure of biology's ontology) embody and perform very important rhetorical goals, and the dialogical placement of concepts equally within abstract mathematical and biological contexts is itself the result of the kind of *constitutive* rhetoric arguably similar to what Reyes finds operative in his treatment of Newton and Leibniz's work with infinitesimals. And further, Reye's rhetorical take on mathematical novelty can perhaps help to expand and indicate with more clarity what exactly Chatin is really saying in his "analogy" between mathematical creativity and the kind of creativity seen in the productive processes and products of biological evolution, perhaps its more intellectually appropriate and generative to consider Chaitin's meta-disciplinary leaps as having a constitutively rhetorical ingredient in them, if we also posit this rhetoricity within the creativity that mathematics demonstrates through novel conceptualizations (ex. infinitesimal calculus or Metabiology's use of AIT), and as a feature of the "postmodern" *non*-formal-axiomatic mathematics that Chaitin performs and advocates for.

Conclusion

What the notion of meta-disciplinarity indicates in the case of Chaitin's Metabiology is that the controversy, (if there is any, which of course depends on who you ask), is controversial due to Chaitin's treatment of entire disciplines (and the semantic communities therein) in relation to one another: he does not signal or indicate when his analogy between two different things (computational and biological information) becomes a metonymy that renders biology qualitatively indistinguishable from pure mathematics[21] and instead differentiates the disciplines through a reduced quantitative disparity between relative amounts of complexity (again, math is *more* biological than biology). The case of Metabiology here presented indicates a post-incommensurability centered scientific rhetoric, where an unchecked inter-disciplinary impulse and an analogy across disciplines becomes an ontology that connects the "essence" of both biology and pure mathematics at a level that is controversial in its meta-framing of the disciplines themselves. Chaitin's Metabiology, I argue, presents the kind of disciplinary violence that rhetoricians of science should themselves be weary of, as it conceals its imperialistic disciplinary rhetoric through an optimistic image of mutually beneficial inter-disciplinary exchanges, of terms, concepts, and/or ideas. However, the inaugural exigency of Metabiology is precisely the result of a meta-disciplinary staging in the first place: Chaitin, as a mathematician, sees a lacking in theoretical biology according to the standards of his own respective field's epistemic standards, and the ontological assumptions that underwrite them (a quasi-platonic mathematical real precedes and animates material biological reality): Darwinian evolution demands proof at the abstract level of pure mathematics, as an expression in pure math would secure the theory beyond the shadow of any doubt, at least from the perspective of mathematicians. Chaitin attempts to inaugurate an entire field of inquiry without preserving the "demarcation claims" of biology, which fully embraces mathematical methods at the inter-disciplinary

[21] More specifically the inaccessible realm of algorithmic information theory Chaitin is using in the toy-model.

level but does not translate the efficacy of mathematical methodologies into a final philosophical hierarchy that renders biological reality but an effect of an ontologically prior mathematical creativity. The warning of disciplinary imperialism lurking behind inter-disciplinary exchanges offered by Chaitin's Metabiology is matched with an invitation to further engage mathematics from the position of rhetoric, and there is a sense in which Chaitin's argument for the necessity of creativity in mathematics, invites scholars of rhetoric to further pursue the intersection of rhetorical invention and mathematical creativity.

Bibliography

Graham, S.S. & Walsh, L. (forthcoming). “There's No Such Thing as a Scientific Controversy”. Technical Communication Quarterly.

Reyes, Mitchell G. "The Rhetoric in Mathematics: Newton, Leibniz, the Calculus, and the Rhetorical Force of the Infinitesimal." Quarterly Journal of Speech, vol. 90, no. 2, 2004, pp. 163-188.

Chaitin, Gregory J. “Proving Darwin: Making Biology Mathematical.” Pantheon Books, New York, 2012.

Siedliński, Radosław. "Turing Machines and Evolution. A Critique of Gregory Chaitin’s Metabiology." Studies in Logic, Grammar and Rhetoric, vol. 48, no. 1, 2016, pp. 133-150.

Fallis, Don. "The Source of Chaitin's Incorrectness." Philosophia Mathematica, vol. 4, no. 3, 1996, pp. 261-269.

Wynn, James. “Evolution by the Numbers: The Origins of Mathematical Argument in Biology”. Parlor Press, Anderson, 2012; 2007

Fahnestock, Jeanne. "Arguing in different forums: The Bering crossover controversy." Science, Technology, & Human Values 14.1 (1989): 26-42. Reprinted in Landmark essays on rhetoric of science: Case studies 11 (1997): 53-67.

Fahnestock, Jeanne. (2004). “Preserving the Figure: Consistency in the Presentation of Scientific Arguments.” Written Communication 21 (1):6–31.

Blakeslee, Ann M. “Interacting with audiences: Social influences on the production of scientific writing.” Routledge, 2000.

Ewert W, Dembski WA, Marks II RJ (2013) “Active Information in Metabiology”. BIO-Complexity 2013 (4):1–10.

Virginia Chaitin, “A Philosophical Perspective on a Metatheory of Biological Evolution”.Youtube. Web. March 30, 2016).

Chaitin, Gregory J. "Leibniz, information, math and physics." arXiv preprint math/0306303 (2003).

Garver, Eugene. “Aristotle's Rhetoric: An art of character.” University of Chicago Press, 1994.

Chaitin, Gregory J. "Algorithmic information theory." *IBM journal of research and development* 21.4 (1977): 350-359.

Chaitin, Gregory.“Metaphysics, Metamathematics and Metabiology.” *Randomness Through Computation*, 2011, pp. 93–103.,

G. Chaitin, “Evolution of Mutating Software,” EATCS Bulletin 97 (February 2009), pp. 157–164.

Chaitin, Gregory J. “To a mathematical theory of evolution and biological creativity.” Department of Computer Science, The University of Auckland, New Zealand, 2010.

Werth, Alexander. "Unity in diversity: the virtues of a metadisciplinary perspective in liberal arts education." *Journal of the National Collegiate Honors Council--Online Archive*(2003): 118.

Harris, Randy Allen. “Landmark Essays on Rhetoric of Science: Case Studies.” Routledge, 2018.

Gross, Alan G., and William M. Keith. “Rhetorical Hermeneutics: Invention and Interpretation in the Age of Science.” State University of New York Press, 1997.

Harris, Randy Allen. “Rhetoric and Incommensurability.” Parlor Press, 2005.